

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER EXAMINATIONS – MAY 2002
PRINCIPLES OF PROCESS ENGINEERING – SCH 2218
TIME – (3) THREE HOURS

INSTRUCTIONS TO CANDIDATES

Answer **ANY FIVE** questions from this paper.

1. (a) State the equation for a pseudoplastic and dilatant fluids. What does each term represent. (6 marks)
- (b) Why are Bingham plastic fluids classified under Non-Newtonian fluids. Give one example of a Bingham plastic fluid. (4 marks)
- (c) Derive Newton's Law of Viscosity Equation. (10 marks)
2. Dimensional analysis is to be used to correlate data on bubble size with the properties of the liquid when gas bubbles are formed by a gas issuing from a small orifice below the liquid surface. Assume the significant variables are bubble diameter D , orifice diameter d , liquid density ρ , surface tension δ in N/m, liquid viscosity μ and acceleration due to gravity g . Use d , ρ , and g as the core group. (20 marks)
3. (a) Sketch the diagram of a triple effect backward feed evaporator system. Show the heat balance equations for such a system. (10 marks)
- (b) Why is it necessary to use pumps in a triple effect backward feed evaporator system. (2 marks)
- (c) A feed of 3 500kg/h of a 2.5 wt% salt solution at 315K enters continuously in a single effect evaporator and is being concentrated to 6 wt%. The evaporator is at atmospheric pressure and the area of the evaporator is 60m². Steam at 380K is supplied for heating. Since the solution is dilute, it can be assumed to have the same boiling point as water. The heat capacity of the feed can be taken as $C_p = 4.10\text{kJ/kgK}$. Calculate the amounts of vapour and liquid product and the overall heat transfer coefficient given that:
 $\lambda = 2230\text{kJ/kg}$
 $H_v = 2257\text{kJ/kg}$ (8 marks)
4. (a) State **Any Two** advantages of drying process as a unit operation. What is the major disadvantage of drying. (4 marks)

4. (b) With the aid of a diagram, discuss *Any Two* of the following drying equipment:
- (i) Freeze Dryer
 - (ii) Spray Dryer
 - (iii) Rotary Drum Dryer (16 marks)
5. (a) The inside of a baking oven is at a temperature of 95°C. The wall of the oven is made of 5mm thick stainless steel of thermal conductivity 15.1W/mK. Determine the heat loss per unit area from the oven if the outside is at a temperature of 19°C (10 marks)
5. (b) If a 5mm thick insulator is fitted onto the stainless steel shell of the above oven, determine the heat loss per unit area for the same inside and outside temperatures. (Thermal conductivity of the insulator is 0.48w/mK) (10 marks)
6. (a) Determine the pressure drop along a 20m long, 5cm diameter pipe in which a fluid with the following properties is flowing.
- Density = 1100kg/m³
 Viscosity = 11.6 x 10⁻²Nsm⁻²
 Velocity = 0.5ms⁻¹
- $f = \frac{16}{Re}$
- or $f = 0.0079Re^{-0.25}$ (12 marks)
- (b) What is steady state flow of a liquid. (2 marks)

END OF QUESTION PAPER!!!